Vehicle Damage Vs Passenger Injury

"The amount of damage sustained by the car bears little relationship to the force applied. To take an extreme example: If the car was struck in concrete, the damage sustained might be very great but the occupants would not be injured because the car could not move forward, whereas, on ice, the damage to the car could be slight but the injuries sustained might be severe because of the rapid acceleration permitted."

Macnab, in The Spine, Saunders, 1982, p. 648.

Other Factors Influencing Injury

Central Canal Stenosis Factor

The central neural canal is the hole where the spinal cord resides. This hole can be narrowed because of congenital reasons or from acquired reasons such as degenerative disc disease protrusion.

When this occurs, it is called stenosis of the central neural canal. The central neural canal also narrows in extension or hyper-extension, YET the spinal cord thickens in extension or hyperextension. Therefore, if the patient has pre-accident central neural canal stenosis, his/her spinal cord and its coverings can become injuries during an extension mechanism injury. This is coupled with a poor prognosis for recovery.

"J.T. McLaughlin has shown that when a 3500 lb. car traveling at 10 mph strikes the rear of another car it may transmit to this car a force of 25 tons. The person's body (in the car that is struck) continues to move forward while, being hinged at the neck, snaps backward. The average head weighs about 8 lbs., and the cervical vertebrae are very delicate; the force that is pushing the head backward is even greater than believed, since the base of the neck acts as a fulcrum and the leverage is applied near the top of the head. Therefore, the head snaps back with the equivalent of several tons of force without any support, since the muscle control of the neck is caught off guard. The end result, with the neck in acute hyperextension, is a momentary posterior subluxation of the various joints with fleeting narrowing of the foramina, so that the nerve root is caught in a pinchers between the superior and inferior facets."

Seletz, Whiplash Injuries, JAMA, Nov.29, 1958

The Awareness Factor

If the passenger is aware of and anticipates a collision, and makes his neck muscle tense, he can tolerate more severe impact. Emori, Whiplash in Low Speed Vehicle Collisions, SAE, Feb, 1990, p.108

Teasell, in Spine: State of the Art Reviews: Cervical Flexion-Extension/Whiplash Injuries, Hanley & Belfus, Sept. 1993, p. 374

Injury is greater "when the impact is unexpected and the victim is unable to brace"

Teasell & McCain, in Pain Cervical Trauma, Williams and Wilkins, 1992, p.293.

Injury results because the neck is unable to adequately compensate for the rapidity of head and torso movement resulting from the acceleration forces generated at the time of impact. This is particularly true when the impact is unexpected and the victim is unable to brace for it."

Smith states (1993): Research has shown that an occupant aware of an impeding impact may possess sufficient muscle control to prevent hyper flexion and hyperextension during low velocity impacts.

Lord, in Spine: State of the Art Reviews: Cervical Flexion-Extension/Whiplash Injuries, Hanley & Belfus, Sept. 1993, p. 360.

In a whiplash injury, the acceleration-deceleration movements of the neck are typically completed within 250 ms. The brevity of this period precludes any voluntary of reflex muscle response that might arrest, limit, or control the movements of a cervical motion segment. Without muscle control the normal arcuate movement of a cervical motion segment must be disturbed, and forces to which individual segments are subjected can be resisted only by passive ligamentous elements or bony contact. This sets the scene for a variety of possible injuries.

Barnsley, in Spine: State of the Art Review: Cervical Flexion-Extension/Whiplash Injuries, Hanley & Belfus, Sept. 1993, p.329

"If the head is in slight rotation, a rear-end impact will force the head into further rotation before extension occurs. This has important consequences because cervical rotation prestressed various cervical structures, including the capsules of the zygapophseal joints, intervertebral discs, and the alar ligament complex, making them more susceptible to injury."

Havsy, Whiplash Injuries of the Cervical Spine and Their Clinical Sequelae, Am Journal of Pain Management, January, 1994.

"Injuries are greater when nonsymmetrical loads are applied to the spine. This occurs when the spine sustains a rotatory injury. The injuries are increased because the facet joints lock-out spinal motion, making the neck rigid, less resilient, and more susceptible to injury.

When the head is rotated 45 to one side, the amount of extension that side of the spine is capable of is decreased by 50%. This results in increased compressive loads on the face joints, articular pillars on the ipsilateral side, and increased tensor loads at the facet joints on the contralateral side. The intervertebral foramen are smaller on the side of rotation and lateral flexion, and the neurovascular bundles are more vulnerable to compressive injuries."

The Pre-Accident Degenerative Joint Disease Factor

Pre-existing degenerative joint disease renders such joints less capable of adequately handling and dispersing the forces of a new injury; therefore, injury to these articulations and the surrounding tissues is greater; the amount of treatment required for maximum improvement is greater; there are more long term subjective, objective, and functional residuals; and the probability of accelerated progression of additional degenerative joint increases to 55% probable.

Turek, Orthopaedics Principles and their Applications, Lippincott, 1977, p.740.

“The injury may be compounded by the presence of degenerative disease of the spine.”

“With advancing age, especially in the presence of degenerative disease, the tissues become inelastic and are easily torn.”

Cailliet, Neck And Arm Pain, F.A. Davis Company, 1981, p. 103.

“The pre-existence of degeneration may have been quiescent in that no symptoms were noted, but now minor trauma may “decompensate” the safety margin and symptoms occur.”

Webb, Whiplash: Mechanism and Patters of Tissue Injury, Journal of the Australian Chiropractors’ Association, June, 1985.

“Degenerative joint disease is recognized as a major influence on subsequent tissue damage both in severity and pattern.”"In any individual where changes consistent with degenerative joint disease are present, one can expect the injury to produce severe symptoms requiring prolonged treatment.”

The Rear-End Mechanism Extension/Compression Factor

Jackson, The Cervical Syndrome, Thomas, 1978, p 90

“because of this shortening of the neck and avulsive or compressive injury must occur somewhere in the cervical spine.

Calliet, Neck and Arm Pain, Davis Company, 1981, p.81

During, the rear-end collision, because of the cervical lordotic curve, “mathematically and geometrically, the neck is considered to shorten as much as an inch or more and to be under a compressive force of 500 to 600 pounds.”

Holm, in The Cervical Spine, Lippincott, 1989, p.440.

“Follow-up roentgenograms taken an average of 7 years after injury in one series of patients without prior roentgenographic evidence of disc disease indicated that 39% had developed degenerative disc disease at one or more disc levels since injury. It was pointed out that available evidence indicated an expected incidence of 6% degenerative change in a population with this mean age of 30 year.

Thus, it appeared that the injury gad started the slow process of disc degeneration. In another follow-up study of patients with similar injuries but with preexisting degenerative changes in the neck it was observed that after an average of 7 years 39% had residual symptoms, and roentgenographic evidence of new degenerative change at another level occurred in 55%.”

Barnsley, in Spine: State of the Art Reviews: Cervical Flexion-/Extension/Whiplash Injuries, Hanley & Belfus, Sept. 1993, p.334 & 335.

“Injuries to the intervertebral discs have repeatedly been reported from a number of sources.”

“it has been suggested that anterior tears could result from the nucleus pulposus bursting through the anterior annulus after being compressed by the extension of the motion segment.”

Ameis, Cervical Whiplash: Considerations in the rehabilitation of Cervical Myofascial Injury, Canadian Family Physician, September, 1986.

“For the elderly, neck injury can be very serious. The degenerative spine, is biomechanically “stiffer” behaving more like a single long bone than like a set evenly dissipated, and more damage is done.”

Dunn, Soft-Tissue injuries of the Lower Cervical Spine, Instructional Course Lectures, Am Academy of Orthopedic Surgeons, 36, 1987.

“If present, degenerative changes should be duly noted as they may affect the prognosis.”

“…preexisting degenerative changes adversely affected the outcome.”

Mairmaris, Whiplash injuries’ of the neck: a retrospective study, Injury: the British Journal of Accident Surgery, 1988.

“The analysis of the radiological results showed that pre-existing degenerative of a poor prognosis.”

Hirsh, Whiplash Syndrome, Fact of Fiction?, Orthopedic Clinics of North America, October, 1988.

“The films should be inspected especially for evidence of pre-existing structural changes or for alteration, which are frequently associated with a more difficult, more prolonged, and less complete recovery. These changes may include the presence of osteophyte, foraminal encroachment on the oblique projections, and the presence of intervertebral disc space narrowing. When hyperextension injury occurs in the presence of pre-existing osteophyte formation, there is further narrowing of the spinal canal, which increases the potential for injury to the verve roots or cord.”

Foreman and Croft, Whiplash Injuries, The Acceleration/Deceleration Syndrome, Williams & Wilkins, 1988, p. 389 and p.395.

“…the presence of preexisting degenerative changes, no matter how slight, appears to alter the prognosis adversely.”

Porter, Neck Sprains After Car Accidents, British Medical Journal, April, 1989.

“Pre-existing degenerative changes may worsen the prognosis.”

Holm, Soft-Tissue Neck Injuries, in The Cervical Spine, The Cervical Spine Research Society, Sherk editor, Lippincott, 1989, p.440.

“In a follow-up study of patients with similar injuries but with preexisting degenerative changes in the neck, it was observed that after an average of 7 years 39% had residual symptoms, and roentgenographic evidence of new degenerative change at another level occurred in 55%.”

Watkinson, Prognostic factors in soft tissue injuries of the cervical spine, Injury: the British Journal of Accident Surgery, No. 4, 1991.

“Patients with Degenerative change initially have more symptoms after 2 years than those with normal radiographs at the time of injury.”

Navin and Romilly state (1989):

…experimental results indicate that some vehicles can withstand a reasonable high speed impact without significant structural damage. The resulting occupant motions are marked by a lag interval, followed by a potentially dangerous acceleration up to speeds greater than that of the vehicle..

A review of accident reports indicates that a significant percentage occur with little or no accompanying vehicle damage. As the vehicle becomes stiffer, the vehicle damage costs are reduced as less permanent deformation takes place. However, the occupant experiences a more violent ride down which increases the potential for injury.

…the average acceleration experienced by the occupant in the elastic (no damage) vehicle would be approximately twice that of the plastic [structurally damaged] vehicle. This theory implies that vehicles which do not sustain damage in low speed impacts can produce correspondingly higher dynamic loadings on their occupants than those which plastically deform under the same of more severe impact conditions.

Emori and Horiguchi, (1990):

Neck extension became almost 60 degrees which is the potential danger limit of whiplash, at collision speed as low as 2.5 km/h.

Macnab states that: (1982):

The amount of damage sustained by the car bears little relationship to the force applied. To take an extreme example: If the car was struck in concrete, the damage sustained might be very great but the occupants would not be injured because the car could not move forward, whereas, on ice, the damage to the car could be slight but the injuries sustained might be severe because of the rapid acceleration permitted.”

Carroll et. al. state (1986):

The amount of damage to the automobile bears little relationship to the forces applied to the cervical spine of the occupants. The acceleration of the occupant’s head depends upon the force imparted, the moment of inertia of the struck vehicle, and the amount of collapse of force dissemination by the crumpling of the vehicle.

Amseis states (1986):

“Each accident must be analyzed in its own right. Auto speed and damage are not reliable parameters.”

Hirsch et al state (1988):

“The amount of damage to the automobile may bear little relationship to the forces applied to the cervical spine and to the injury sustained by the cervical spine.”

Smith states (1993):

The absence or presence of vehicle damage is not a reliable indicator of injury potential in rear impacts. Based upon the principle of conservation of energy, any energy which does not go into damaging the vehicle must be converted into kinetic energy, the source of injuries.

Nordhoff and Emory state (1996):

Historically, insurance company claims adjusters have assumed that collision injuries correlate to the vehicle external structural damage and cost repair. The assumption that injuries relate to the amount of external vehicle damage in all types of crashes has nonscientific basis. There is little correlation between neck injury and vehicle damage in the low speed rear end collision.

Importantly, recent published studies have reviewed both the presenting and long term clinical status of consecutive patients injured in motor vehicle collisions. Their conclusions support the mathematical principles of collision physics, the experimental studies of staged collisions, and the observations of published experts. Specifically, Parmar and Raymakers (1993) reviewed 100 patients who had injured their necks in rear impact road traffic accidents.They state:

There was no-relationship between the prognosis and the type of car or the severity of damage it sustained. Some factors bore no relationship to the prognosis and they included…the amount of damage sustained by the vehicle.

Sturrenegger et. al. (1994) reviewed 137 consecutive patients after whiplash injury. Their study specifically excluded patients with fractures, dislocations, head trauma, and preexisting neurological disorders The article states:

The amount of damage to the automobile and the speed of the cars involved in the collision bear little relationship to the injury sustained by the cervical spine. …the velocities of the involved vehicles and the extent of car damage are not directly related to the forces acting on the cervical spine.

Ryan et. al. (1994) reviewed 29 individuals who sustained a neck strain as a result of a car crash, and followed them for a period of six months. They conclude:

No statistically significant associations between crash severity and 6-month injury status were found, …there were no statistically significant relationships between injury status at 6 months and either measure of crash severity. …there were no statistically significant associations between crash severity variables and injury status at 6 months…

Sturrenegger et. al. in another published study (1995) followed 117 consecutive whiplash patients for more than 12 months. Again the authors state:

Attempts to correlate outcome with extent of damage to the involved cars and their speed has previously been shown to be of little prognostic value.

The question arises then why it is that occupants involved in seemingly small collisions have such significant symptoms and poor prognosis? Part of the answer is because the kinetic energy that creates occupant injury is increased, as explained above. A second part of the answer is that these low speed rear impacts are capable of producing high accelerations to the vehicle occupants.

Mcconnell et. al. (1995) analyzed the head and neck kinematics of eighteen human volunteers subjected to rear impacts between 3.6- 6.8 mph. All volunteers were male of apparently good health, and of course were unaware of the fact that they were to be in a rear impact collision. All test subjects reported some test related awareness or discomfort symptoms. The tangential acceleration was found to typically reach values exceeding 10 G's during the period to 150 msec after the impact.

The third part of the answer concerns itself with the specific moment of impact biomechanics of the vehicle occupant. Historically, authors have published an empirical association between whiplash type neck injuries and patient awareness prior to impact, and position of patient's head prior to impact. Importantly, research by Sturzenegger et. al. (1994), Ryan et. al. (1994), and Sturzenegger et. al. (1995) substantiates the empirical historical perspective that occupant awareness and head position are significant factors in injury and prognoses.

Head Position Factor

With respect to head position at the moment of impact,

Turek states: (1977):

When the direction of force is from the side, or when a frontal or rear force occurs while the head is turned to one side, the spine is less flexible and the force is expended upon the articulations where the small bone elements may be fractured.

Cailliet (1981) indicates that if the head is turned at the moment of impact, there is increased injury on the side to which the head is turned, as:

…not only will the already narrowed foramen be compressed more, but the torque effect on the facets, capsules, and ligaments will be far more damaging.

Webb states (1985):

When the hyper flexion-hyperextension or hyperextension-hyper flexion occurs with head rotation present, the pattern of tissue injury is different, and the extent of damage produced is always more severe. Rotation increases stress in certain soft tissue structures, which then reach their limit of motion at an earlier point, thus resulting in more severe injury with less application of force, it has also been shown that extension with pre-existing rotation is more likely to rupture the anterior or longitudinal ligament than simple extension.

Research by Sturzenegger et. al. (1994) state:

Rotated and inclined head position both led to a significantly higher frequency of multiple symptoms and increased neck pain and headache intensity, and showed a trend to shorter latency of headache onset. In addition, inclined head position caused more frequent cranial nerve or brainstem dysfunction and more

frequent visual disturbances. Both rotated and inclined head positions showed a significant relationship with signs of radicular deficit.

Research by Sturzenegger et. al (1995) state the following set of variables predicted persistence of symptoms at 1 year:

…rotated or inclined head position,,. Rotated as well as inclined of bead position showed a significantly higher incidence in the symptomatic group.

Rebound Hyper flexion

McKenzie, The Dynamic Behavior of the Head and Cervical Spine During Whiplash, Journal of Biomechanics, vol.4, 1971, p.477.

“during rebound hyper flexion, the head will reach an acceleration greater than the acceleration of the vehicle, usually 2- 2.5 greater.”

Havsy, in Am J. of Pain Mang, Whiplash Injures of the Cervical Spine and Their Clinical Sequelae, Jan. 1994, p.30.

“in some cases, the head may accelerated up to five times the input acceleration”

Thereby creating a unique injuring principle, called:

MAGNIFICATION OF ACCELERATIONS

Charles Carroll, M.D., Paul McAfee, M.D. and Lee Riley, Jr.,M.D. Came to much the same conclusion in their article “Objective Findings for Diagnosis of Whiplash in the Journal of Musculoskeletal Medicine, March 1986. They noted that “The amount of damage to the automobile bears little relation to the force applied to the cervical spine of the occupants. The acceleration of the occupant’s head depends on the force imparted, the moment of inertia of the struck vehicle, and the amount of collapse of force dissemination by the crumpling of the vehicle.”

Several other medical authorities corroborate this opinion:

“The accident does not need to be severe in order to generate cervical trauma. Using the brakes when the light suddenly turns red and when the neck is too relaxed is enough to cause trauma. The neck may be projected backwards though not violently. The head, which weighs five kilograms and is balanced over the cervical spine, being supported by only two small articular surfaces no greater than a thumbnail, is also thrown backwards pulling the cervical spine with it.”– Robert Maigne, M.D. orthopedic Medicine, “A New Approach to Vertebral Manipulations,”CC Thomas, 1972.

“Injuries may result from sudden acceleration and deceleration of motor vehicles, which our present high-powered engines permit, may cause a forceful hyperextension of the neck of an unsuspecting passenger.” — Ruth Jackson, M.D., The Cervical Syndrome, fourth ed., 1977.

It is obvious, then, that there is a great deal of medical and chiropractic research and literature to substantiate our concern over an accident victim's welfare, even in the case of a "little" accident.

Armed with the proper health care facts–or working with an informed chiropractor– it is not difficult to convince insurance officials, judges, or juries, that an accident victim is being prudent by seeking out proper chiropractic health care, and demanding adequate financial compensation even in those accidents which did not result in major property damage.

–Reprinted from the PI/DC Report, 1988

Conclusion

Motor vehicle collision patient/passenger injury and clinical prognosis for recovery is not related to the damage of their vehicle. Rather, injury and prognosis are coupled with direction of impact (rear-end), awareness, and head/neck rotation or inclination.

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